fluid

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1 Flow past a cylinder

Let ρ_0 be the radius of the cylinder, ρ, ξ the polar coordinate system in use. One possible solution of this problem have these potential and streamline functions:

$$\phi(\rho, \xi) = \left(\rho + \frac{\rho_0^2}{\rho}\right) \cos \xi \tag{1}$$

$$\psi(\rho, \xi) = \left(\rho - \frac{\rho_0^2}{\rho}\right) \sin \xi \tag{2}$$

Although these equations are deeply coupled, the radius ρ and the phase ξ can be obtained as a function of the other quantities. For our purposes, we use ψ.

$$\rho(\psi, \xi) = \frac{\psi + \sqrt{\psi^2 + 4\rho_0^2 \sin^2 \xi}}{2 \sin \xi} \tag{3}$$

$$\xi(\psi, \rho) = \arcsin\left(\frac{\rho\, \psi}{\rho^2 - \rho_0^2}\right) \tag{4}$$

2 Conformal mapping

From the reference plane, which is equivalent to a two-pole machine, we use a complex map to obtain the quantities in the actual plane. Let p be the number of pole pairs. Then:

$$\begin{aligned} \zeta &\xrightarrow{\mathcal{M}} z = \sqrt[p]{\zeta} \\ \rho\,\mathrm{e}^{\mathrm{j}\xi} &\xrightarrow{\mathcal{M}} r\,\mathrm{e}^{\mathrm{j}\vartheta} = \sqrt[p]{\rho}\,\mathrm{e}^{\mathrm{j}\xi/p} \\ \chi + \mathrm{j}\eta &\xrightarrow{\mathcal{M}} x + \mathrm{j}y \end{aligned} \tag{5}$$

It is easy to find the inverse map:

$$\mathcal{M}\colon \sqrt[p]{\cdot} \qquad \mathcal{M}^{-1}\colon (.)^p \tag{6}$$

3 Computation of flux-barrier base points

Let the flux-barrier and flux-carrier thicknesses be given. Then the base points for the flux-barriers can be computed easily.

3.1 Magnet insertion

$$t_{\mathrm{rib}} = t_{\mathrm{rib}} + w_{\mathrm{m}}$$

where w_{m} is the magnet width.

3.2 Central base points

The line describing the q-axis is

$$\begin{aligned} y &= mx + q \\ m &= \tan\frac{\pi}{2p} \\ q &= \frac{t_{\mathrm{rib}}}{\cos\frac{\pi}{2p}} \end{aligned} \tag{7}$$

$$\begin{cases} y_c - mx_c - q = 0 \\ x_c - r_c(\psi_c, \theta_c)\cos\theta_c = 0 \\ y_c - r_c(\psi_c, \theta_c)\sin\theta_c = 0 \end{cases} \tag{8}$$